

MIL-L-13808E(MR)
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SUPERSEDING
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MILITARY SPECIFICATION

LEAD PLATING, ELECTRODEPOSITED

This specification is approved for use by all
Departments and Agencies of the Department of
Defense.

1. SCOPE

1.1 Scope. This specification covers electrodeposited lead plating applied to iron and steel, copper, and copper-rich surfaces (see 6.1).

1.2 Classification. Lead plating shall be of the following types and classes, as specified (see 6.2):

Type I - without preliminary copper coating

Class 1 - 25 micrometers (0.001 inch) thick lead coating

Class 2 - 13 micrometers (0.0005 inch) thick lead coating

Class 3 - 6 micrometers (0.00025 inch) thick lead coating

Type II - with 0.33 micrometer* (0.000015 inch) thick preliminary copper coating (see 6.1.2)

Class 1 - 25 micrometers (0.001 inch) thick lead coating

Class 2 - 13 micrometers (0.0005 inch) thick lead coating

Class 3 - 6 micrometers (0.00025 inch) thick lead coating

* To attain 0.33 micrometer (0.000015 inch) of copper from a cyanide bath operating at 50 percent cathode efficiency will require about 1 minute of plating at a current density of 16 amperes per square foot or correspondingly shorter period for higher current densities.

Area MFFP

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2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, forms a part of this specification to the extent specified herein.

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

MIL-STD-109 - Quality Assurance Terms and Definitions

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards

- B 117 - Salt Spray (Fog) Testing
- B 487 - Measuring Metal and Oxide Coating Thickness by Microscopic Examination of a Cross Section
- B 499 - Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metal
- B 529 - Measurement of Coating Thicknesses by the Eddy-Current Test Method: Nonconductive Coatings on Nonmagnetic Basis Metals
- B 567 - Coating Thickness by the Beta Backscatter Principle
- B 568 - Coating Thickness by X-Ray Spectrometry

(Application for copies should be addressed to American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Materials. The materials used for electroplating shall produce coatings which meet the requirements of this specification.

3.2 Basis material. The basis material shall be free from defects that will be detrimental to the appearance or protective value of the plating.

3.3 General requirements.

3.3.1 Preplating operations. Unless otherwise specified in the contract or purchase order, the items to be plated shall be subjected to all the required mechanical operations, such as machining, brazing, welding, forming and perforating, prior to the application of the specified type and class of plating. The cleaning and finishing operations shall be performed with minimum abrasion, erosion, or pitting of the surfaces.

3.3.2 Stress relief treatment. All items made of metal having a hardness of Rockwell C40, or greater (see 3.3.3) shall be given a suitable heat treatment to remove any objectionable residual stresses, prior to being subjected to the final cleaning and plating operations.

3.3.3 Embrittlement relief. All items, such as springs, which are subject to flexure or repeated impact in their normal functions, or steels having a hardness of Rockwell C40 or over, shall be heat-treated for 3 hours at $191^{\circ} \pm 14^{\circ}\text{C}$ ($375^{\circ} \pm 25^{\circ}\text{F}$) after being plated. However, all hardened springs and carburized parts, which have been heat-treated prior to plating at a temperature lower than 191°C (375°F) shall not be subjected to the specified after plating heat treatment. Instead such parts shall be heat-treated by a method or procedure which has the previous approval of the procuring agency. Plated springs shall not be flexed prior to the specified heat treatment in any case.

3.3.4 Deposition of the coating.

3.3.4.1 Type I plating. The appropriate thickness of lead coating corresponding to the specified class of lead plating (see table I) (3.4.1.1), shall be electrodeposited directly on the surface to be protected.

3.3.4.2 Type II plating. A preliminary copper coating, of the thickness specified (see table II) (3.4.1.2), shall be electrodeposited directly on the surface to be protected. Subsequently the appropriate thickness of lead coating corresponding to the specified class of lead plating (see table I) (3.4.1.1), shall be electrodeposited on the copper coating.

3.4 Detail requirements.

3.4.1 Thickness of coating.

3.4.1.1 Type I plating. The average minimum thickness of the lead coating on all significant surfaces of the plated items (see 6.4) which can be touched by a ball 19 millimeters (0.75 inch) in diameter, shall be as shown in table I. The minimum thickness of the coating at any point on the surface of the plated item shall be not less than 70 percent of the minimum average thickness stipulated in table I for the specified class of plating. The thickness of the coating shall be determined by the applicable procedure specified in 4.4.1.

Table I. Thickness of lead coating
for type I plating

Class of plating	Average minimum thickness	
	Micrometers	Inches
1	25	0.001
2	13	0.0005
3	6	0.00025

3.4.1.2 Type II plating. The average minimum thickness of the preliminary copper coating, and of the outer lead coating on all significant surfaces of the plated items (see 6.4) which can be touched by a ball 19 millimeters (0.75 inch) in diameter, shall be as shown in table II for the specified class of plating. The minimum thickness of the copper and lead coatings at any point on the surface of the plated item shall be not less than 70 percent of the minimum average thickness shown in table II for the specified class of plating. The thickness of the coatings shall be determined by the applicable procedure specified in 4.4.1.

Table II. Thickness of copper and lead coatings for type II plating.

Class of plating	Average minimum thickness			
	Copper coating		Lead coating	
	Micrometers	Inches	Micrometers	Inches
1	0.33	0.000015	25	0.001
2	0.33	0.000015	13	0.0005
3	0.33	0.000015	6	0.00025

3.4.2 Salt spray (fog) requirements. When subjected to the 5 percent salt-spray test specified in 4.4.2 for the applicable continuous length of time shown in table III for the specified type and class of plating, the coating on iron or steel basis metal shall give satisfactory protection against corrosion. For purposes of evaluating the protective value of the coating, the following test results shall be considered satisfactory:

a. The formation of not more than 66 rust spots, none of which shall be larger than 1.6 millimeters (1/16 inch) in diameter, per square meter of plated surface (6 per square foot); or

b. The formation of not more than 2 such rust spots when the coated surface area does not exceed 3 square decimeters (1/3 square foot).

The formation of any rust spot larger than 1.6 millimeter (1/16 inch) in diameter on any test specimen, regardless of total area of plated surface, or the occurrence of rust spots in excess of the limits specified above, shall be cause for rejection of the plating under test (see 4.4.2).

Table III. Salt spray (fog) exposure of the lead plating

Type and class of plating	Salt spray exposure time, hours
Type I or II: Class 1	96
Class 2	48
Class 3	24

3.5 Adhesion. The adhesion of the plating shall be such that when examined at a magnification of approximately 4 diameters, it shall not show separation from the basis metal at the interface when subjected to the test specified in 4.4.3. The interface between the lead and the basis metal is the surface of the basis metal before plating. The formation of cracks in the basis metal or plate which do not result in flaking, peeling, or blistering of the plate shall not be considered as nonconformance to this requirement.

3.6 Workmanship. The lead plating shall be smooth, fine grained, adherent, continuous, free from visible blisters, pits, nodules, indications of burning, excessive build-up, staining and other defects. Superficial staining which has been demonstrated as resulting from rinsing, or slight discoloration resulting from baking operations to relieve embrittlement as specified above (see 3.3.3) shall not be cause for rejection. All details of workmanship shall conform to the best practice for high quality plating.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Quality assurance terms and definitions. Reference shall be made to MIL-STD-109 for definition of quality assurance terms.

4.2 Classification of inspection. The inspection requirements specified herein are classified as quality conformance inspection (see 4.3).

4.3 Quality Conformance Inspection.

4.3.1 Lot. A lot shall consist of plated articles of the same type and class and of approximately the same size, form and shape and plated under similar conditions, submitted for inspection at one time.

4.3.2 Sampling for visual examination and nondestructive tests. Sampling for visual examination and nondestructive tests shall be conducted in accordance with MIL-STD-105. A sample of coated parts or articles shall be selected at random from each lot in accordance with MIL-STD-105, Level II. The lot shall be accepted or rejected according to the procedures in 4.3.2.1 for visual examination and 4.3.2.2 for plating thickness (nondestructive tests) at the Acceptable Quality Level (AQL) of 1.5 percent.

4.3.2.1 Visual examination. Samples selected in accordance with 4.3.2 shall be examined for compliance with the requirements of 3.6 after plating. If the number of nonconforming articles exceeds the acceptance number for the sample, the lot represented by the sample shall be rejected.

4.3.2.2 Thickness of plating (nondestructive tests). Samples selected in accordance with 4.3.2 shall be inspected and the plating thickness measured by the applicable tests detailed in 4.4.1. The part or article shall be considered nonconforming if one or more measurements fail to meet the minimum thickness requirements (see 3.4.1.1 and 3.4.1.2). If the number of defective items in any sample exceeds the acceptance number of the specified sample, the lot represented by the sample shall be rejected. Separate specimens (see 4.3.4) shall not be used for thickness measurements unless a need has been demonstrated. The number of separate specimens shall be as specified for sample in 4.3.3.

4.3.3 Sampling for destructive tests. A random sample selected in accordance with table IV, or separately plated specimens prepared in accordance with 4.3.4 shall be tested from each lot for each destructive test.

Table IV. Size of lot sample

Number of items in the lot	Number of items taken for lot sample
2 to 5	1
6 to 25	3
26 to 100	4
101 to 500	6
501 to 3200	10
Over 3200	*

* For lot sizes over 3200 use the sampling schedule of MIL-STD-105, Level S-3, QAL 1.5 percent.

4.3.3.1 Thickness of plating (destructive tests). Samples selected in accordance with 4.3.3 shall be measured for plating thickness by the applicable tests detailed in 4.4.1. The part or article shall be considered nonconforming if one or more measurements fail to meet the minimum thickness requirements (see 3.4.1.1 and 3.4.1.2). If the number of defective items in any sample exceeds the acceptance number of the specified sample, the lot represented by the sample shall be rejected. Separate specimens (see 4.3.4) shall not be used for thickness measurements unless a need has been demonstrated.

4.3.3.2 Adhesion (destructive tests). The articles or specimens used for the destructive thickness test (see 4.3.3.1), if of suitable size and form, may be used as the test pieces for the adhesion test to determine compliance with the requirements of 3.5. Failure of one or more of the test pieces shall constitute failure of the lot, except that for lot sizes over 3200 articles, the requirements of MIL-STD-105, inspection Level S-3, AQL 1.5 percent shall be followed. Separate specimens (see 4.3.4) may be used for the adhesion tests.

4.3.3.3 Salt spray (destructive tests). For both types I and II coatings, the number of articles indicated in table IV shall be taken at random from the lot to be inspected for the salt-spray tests. Failure of one or more articles in the sample shall constitute failure of the lot, except that for lot sizes over 3200 articles, the requirements of MIL-STD-105, inspection Level S-3, AQL 1.5 percent shall be followed.

4.3.3.4 Embrittlement relief. For both types I and II coatings, the number of articles indicated in table IV shall be taken at random from the lot to be inspected for the embrittlement relief tests. Failure of one or more articles in the sample shall constitute failure of the lot, except that for lot sizes over 3200 articles, the requirements of MIL-STD-105, inspection Level S-3, AQL 1.5 percent shall be followed.

4.3.4 Separate specimens. When the plated articles are of such form as to be not readily adaptable to a test specified herein, the test may be made by the use of separate specimens plated concurrently with the articles represented. The separate specimens shall be of a basis metal equivalent to that of the articles represented. "Equivalent" basis metal includes condition and finish of surface prior to plating. For example, a smooth cold-rolled surface should not be employed for representing a hot-rolled surface, but due to the impracticability of hot forging or casting separate test specimens, hot-rolled specimens may be used when plated parts are hot forged or cast. The separate specimens may be strips approximately 1 inch wide, 4 inches long and 0.04 inch thick, for adhesion tests, but shall be at least 4 inches wide, 6 inches long and approximately 0.04 inch thick for all other tests. These

specimens shall be introduced into a lot at regular intervals prior to the cleaning operations preliminary to plating and shall not be separated therefrom until after completion of the processing. Conditions affecting the plating of the specimens including the spacing in respect to anodes and to other objects being plated shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented.

4.4 Test methods.

4.4.1 Thickness. Separate specimens (see 4.3.4) shall not be used for thickness measurements unless a need for such specimens has been shown. Unless otherwise specified, the method of test shall be selected by the supplier with consideration given to basis metal, coating thickness, and the shape of the article. The following ASTM test methods have been found acceptable for measuring coating thickness: B 487 (microscopic), B 499 (magnetic), B 529 (eddy-current), B 567 (beta backscatter), and B 568 (X-ray spectrometry).

4.4.2 Salt spray (fog) test. The salt spray test shall be made in accordance with ASTM method B 117.

4.4.3 Adhesion test. Wherever possible, the test shall be made on a specimen representing the basis material which can be bent 180°. The article or test specimen shall be clamped in a vise and the projecting portion bent back and forth until rupture occurs, or specimens shall be bent repeatedly over a mandrel until rupture occurs. Following fracture of the basis metal, it shall not be possible to detach areas of the coating with a sharp instrument.

4.4.3.1 When the plated articles are not readily adaptable to the bend test, adhesion may be determined on the plated article or on a plated sample representative of the plated article (see 4.3.2) by cutting the plating from the basis metal at the interface in a continuous path. The plate shall then be examined at four diameters magnification to determine whether removal has been caused by the cutting away of an adherent plate or by the lifting of a nonadherent plate.

4.4.4 Embrittlement relief. Inspection for determination of compliance with 3.3.3 shall be made as specified by the procuring agency.

4.5 Retests. Plated items which have been rejected or withdrawn because of the presence of plating defects may be resubmitted after stripping and replating or after screening of the entire lot. Complete

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details of replating shall be furnished to, and be approved by, the procuring activity. Where only insufficient thickness is involved, replating without stripping may be permitted at the discretion of the procuring activity.

5. PREPARATION FOR DELIVERY

5.1 There are no packaging, packing or marking requirements applicable to this specification.

6. NOTES

6.1 Intended use. Lead coatings are used to prevent corrosion, to prevent galling of metal parts, to improve the performance of bearings and to facilitate soldering.

6.1.1 Type I. Lead may be plated directly on copper, brass or copper rich alloy surfaces. For steel surfaces, the type II process with a preliminary copper coating should be used to obtain adequate adhesion and corrosion resistance.

6.1.2 Type II shall be used for all applications except where the presence of the initial thin copper coating is detrimental to the use. The thin undercoat of copper increases the salt spray resistance of lead coatings varying in thickness from 6 to 25 micrometers (0.00025 to 0.001 inch) by as much as a factor of two as well as improving adhesion of the lead to the steel.

6.2 Ordering data. Purchasers shall exercise any option offered herein and procurement documents shall specify the following:

- (a) Title, number and date of this specification.
- (b) Type and class of plating required (see 1.2).
- (c) Method of embrittlement relief testing (see 4.4.4).

6.3 The manufacturer of the basis metal parts shall provide the plating facility with the following data:

- (a) Hardness of steel parts (see 3.3.2 and 3.3.3).
- (b) Whether heat treatment for stress relief has been performed or is required.
- (c) Ultimate use (see 3.3.3).
- (d) Tensile loads and time required for embrittlement relief test (if applicable see 4.4.4).

6.4 Significant surfaces (3.4.1.1) are those surfaces that are visible and subject to wear and corrosion.

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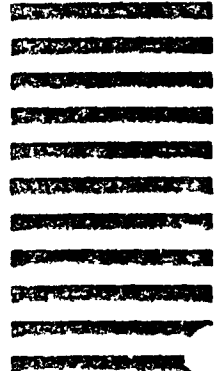
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